PATENT ABSTRACTS OF JAPAN

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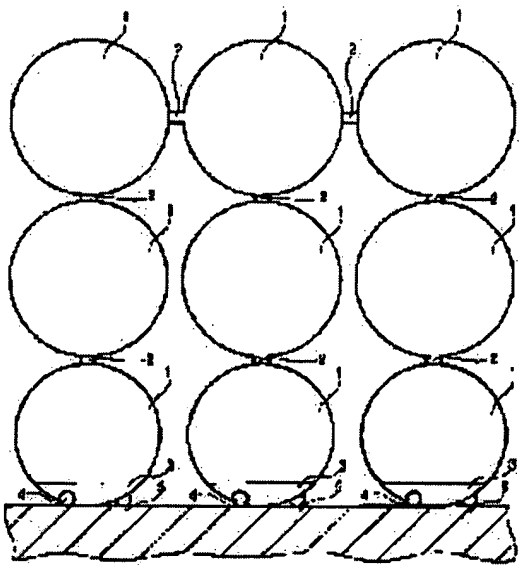
(54) SPHERICAL SEMICONDUCTOR CONTAINING SOLAR BATTERY, AND SPHERICAL SEMICONDUCTOR DEVICE USING SPHERICAL SEMICONDUCTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a solar battery that can be manufactured easily, can be miniaturized, can improve electromotive force per unit area, and is highly efficient, and to provide a semiconductor device that bas generation functions, is compact, and is highly efficient.
SOLUTION: The spherical semiconductor device is provided with a spherical solar battery part having a second-conduction semiconductor layer being formed on a spherical substrate surface where at least a surface composes a first- conduction semiconductor layer so that a pn junction is formed, an outer electrode that is made of a transparent conductive film being formed on the second semiconductor layer surface, and an inner electrode that is connected to the first-conduction-type semiconductor layer and at the same time is taken out onto the surface, and a spherical semiconductor integrated circuit part where an inverter circuit is formed on the spherical semiconductor surface. Also, the outer electrode and the inner electrode of the spherical solar battery part, and the spherical semiconductor integrated circuit are interconnected.



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CLAIMS

[Claim(s)]
[Claim 1] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face are provided. The ground electrode and inside electrode of said spherical solar-battery section, The solar battery with which said spherical semiconductor integrated circuit is characterized by interconnecting.
[Claim 2] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The solar battery characterized by coming to provide the spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which interconnects on said spherical semi-conductor front face with said solar-battery section, and comes to form an inverter circuit in it.
[Claim 3] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face, The semiconductor device characterized by providing the logical circuit section formed in the spherical semi-conductor front face, and the ground electrode of said spherical solar-battery section and an inside electrode, and said spherical semiconductor integrated circuit and said logical circuit section interconnecting through a bump.
[Claim 4] It is the semiconductor device according to claim 3 which makes cluster connection through a bump and is characterized by arranging said spherical solar-battery section at the front-face side so that said spherical solar-battery section, the spherical semiconductor integrated circuit section, and the logical circuit section may be formed in the spherical substrate which became independent, respectively and two or more layer structure may be made on a mounting substrate front face.
[Claim 5] It is the semiconductor device according to claim 4 which said spherical solar-battery section, and the spherical semiconductor integrated circuit section or the logical circuit section is formed in the same spherical substrate, and is characterized by arranging said spherical solar-battery section so that it may be located in the semi-sphere by the side of a front face.
[Claim 6] Said spherical solar-battery section is a semiconductor device according to claim 3 to 5 characterized by providing the bump who connects with a ground electrode and an inside electrode, respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carries out phase opposite, and carrying out the series connection to it through each bump.
[Claim 7] Said spherical substrate is a semiconductor device according to claim 3 to 6 characterized by coming to form pn junction between the amorphous silicon layers of the 2nd conductivity type which consisted of a silicon ball of the 1st conductivity type, and was formed in the front face of said silicon ball.

[Claim 8] Said spherical substrate is a semiconductor device according to claim 3 to 6 characterized by consisting of a metal spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Claim 9] Said spherical substrate is a semiconductor device according to claim 3 to 6 characterized by consisting of an insulating spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Claim 10] Said 1st and 2nd silicon layers are semiconductor devices according to claim 8 characterized by being an amorphous silicon layer.
[Claim 11] Said spherical solar-battery section is a semiconductor device according to claim 3 to 6 characterized by being the thing which comes to form pn junction between the impurity diffused layers of the 2nd conductivity type formed in the front face of the spherical silicon of the 1st conductivity type.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the semiconductor device which used a solar battery and this, and relates to the structure of the solar battery especially using a spherical semi-conductor.
[0002]
[Description of the Prior Art] The electron and electron hole which were generated when the internal field has arisen into the pn junction part of a semi-conductor, light is applied to this and the electron-hole pair was made to generate are separated by the internal field, an electron is brought together in the n side, an electron hole is brought together in the p side, and if a load is connected outside, a current will flow towards the n side from the p side. This effectiveness is used and utilization of a solar battery is advanced as a component which transforms light energy into electrical energy.
[0003] In recent years, the technique of forming a circuit pattern on a spherical semi-conductor (Ball Semiconductor) with a diameter [of single crystal silicon etc.] of 1mm or less, and manufacturing a semiconductor device is developed.
[0004] The manufacture approach of the solar array which connected many semi-conductor particles, using aluminum foil as one is proposed (JP,6-13633,A). By this approach, as shown in drawing 14 , the semi-conductor particle 207 which has the 1st conductivity-type epidermis section and the interior of the 2nd conductivity type is arranged so that it may project from the both sides of aluminum foil 201 in opening of aluminum foil, the epidermis section 209 of one side is removed, and an insulating layer 221 is formed. Next, the part inside [111] the 2nd conductivity type and the insulating layer 221 on it are removed, and the 2nd aluminum foil 219 is combined with the removed field 217. The flat field 217 offers good ohmic contact to the 2nd aluminum foil 219 as a current carrying part.
[0005]
[Problem(s) to be Solved by the Invention] However, by such approach, since there is a limitation in high density arrangement and aluminum foil will exist in the shape of a field, the light to a lower layer will be intercepted with this aluminum foil. Therefore, the semi-conductor particle used as a photoelectrical converter cannot carry out a deer array further, and had become the problem which obstructs that the electromotive force per unit area improves.
[0006] Moreover, although the inverter circuit which changes a direct current into an alternating current was required for such a solar battery, since it connected with a solar battery through aluminum foil 219, this inverter circuit had a long wiring distance, and in order to have to prepare as another semiconductor chip, it had become the problem which obstructs the miniaturization of equipment.
[0007] Even if it faced connection with a logical circuit chip, the wire length to the logical circuit chip driven with this electromotive force became large, and had caused various problems, such as generating of parasitic capacitance, from the ejection terminal of the electromotive force from a solar battery further again.
[0008] This invention was made in view of said actual condition, and aims to let manufacture offer the easy and possible solar battery of a miniaturization. Moreover, this invention aims at offering a scale and an efficient solar battery for improvement in the electromotive force per unit area. This invention possesses a generation-of-electrical-energy function, and aims at offering a small and efficient semiconductor device further again.
[0009]
[Means for Solving the Problem] The semi-conductor layer of the 2nd conductivity type formed so that the 1st solar battery of this invention might form pn junction in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with

the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face are provided. The ground electrode and inside electrode of said spherical solar-battery section, Said spherical semiconductor integrated circuit is characterized by interconnecting.

[0010] According to this configuration, since the inverter circuit formed in the spherical semi-conductor front face is connected to the spherical solar-battery section, it is small, and it becomes possible to offer the small solar battery of a component-side product.

[0011] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 2nd of this invention, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type It is characterized by coming to provide the spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which interconnects on said spherical semi-conductor front face with said solar-battery section, and comes to form an inverter circuit in it.

[0012] According to this configuration, since the solar-battery section and an inverter circuit are provided on the same spherical semi-conductor front face, it becomes possible to offer a small and efficient power unit. Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.

[0013] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 3rd of this invention, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face, The logical circuit section formed in the spherical semi-conductor front face is provided, and the ground electrode of said spherical solar-battery section and an inside electrode, and said spherical semiconductor integrated circuit and said logical circuit section are characterized by interconnecting through a bump.

[0014] It becomes since the electromotive force acquired in the solar-battery section can be directly used in the logical circuit section as it is according to this configuration, when becoming possible to make a wire length small, mounting is also easy, and a component-side product is small, and possible to offer an efficient semiconductor device.

[0015] According to the 4th of this invention, in a semiconductor device according to claim 3, cluster connection is made through a bump and said spherical solar-battery section is characterized by being arranged at the front-face side so that said spherical solar-battery section, the spherical semiconductor integrated circuit section, and the logical circuit section may be formed in the spherical substrate which became independent, respectively and two or more layer structure may be made on a mounting substrate front face.

[0016] According to this configuration, in addition to the effectiveness by the above 4th, the front-face side which is easy to receive light considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the lower layer with small light income becomes able [a component-side product] to obtain a small more efficient semiconductor device.

[0017] According to the 5th of this invention, in a semiconductor device according to claim 4, said spherical solar-battery section, and the spherical semiconductor integrated circuit section or the logical circuit section is formed in the same spherical substrate, and said spherical solar-battery section is characterized by being arranged so that it may be located in the semi-sphere by the side of a front face.

[0018] According to this configuration, in addition to the effectiveness by the above 4th, the front-face side which is easy to receive the light of a spherical semi-conductor considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the rear-face side where light income is small becomes possible [obtaining a small and more efficient semiconductor device].

[0019] According to the 6th of this invention, in a semiconductor device according to claim 3 to 5, said spherical solar-battery section is characterized by providing the bump who connects with a ground electrode and an inside electrode, respectively on the front face on the same diameter on the front face of

a ball passing through the level surface containing a diameter which carries out phase opposite, and carrying out the series connection to it through each bump.
[0020] According to this configuration, it becomes possible to arrange many spherical solar batteries to high density most through a bump, and to connect. Moreover, positioning becomes easy, when arranging the solar-battery section more than two-layer and the space between the spherical semi-conductors by the bump can be used as photoconductive admission into a club.
[0021] According to the 7th of this invention, in a semiconductor device according to claim 3 to 6, said spherical substrate consists of a silicon ball of the 1st conductivity type, and is characterized by coming to form pn junction between the amorphous silicon layers of the 2nd conductivity type formed in the front face of said silicon ball.
[0022] According to this configuration, the approach of whether the amorphous silicon layer of the 2nd conductivity type is deposited on a silicon ball front face and the paddle gap which forms an impurity diffused layer by diffusion enables it very easily to offer a semiconductor device with a large component area.
[0023] According to the 8th of this invention, in a semiconductor device according to claim 3 to 6, it is characterized by said spherical substrate consisting of a metal spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[0024] Since the semi-conductor layer which has pn junction is formed in a front face according to this configuration, using a metal spherule as a base, in order that this metal spherule may play the role of the charge collector of low resistance, it becomes it is very efficient and possible by using the good metal of ohmic contact nature to a semi-conductor layer to plan ejection of electromotive force. You may make it make a barrier layer intervene if needed.
[0025] According to the 9th of this invention, in a semiconductor device according to claim 3 to 6, it is characterized by said spherical substrate consisting of an insulating spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[0026] According to this configuration, it becomes it is cheap and possible to obtain the semiconductor device whose property was stable.
[0027] According to the 10th of this invention, in a semiconductor device according to claim 8, it is characterized by said 1st and 2nd silicon layers being amorphous silicon layers.
[0028] According to this configuration, an amorphous silicon layer can be formed also in an insulating substrate front face as film of high quality, and its property as a solar battery is also good.
[0029] According to the 11th of this invention, in a semiconductor device according to claim 3 to 6, said spherical solar-battery section is characterized by being the thing which comes to form pn junction between the impurity diffused layers of the 2nd conductivity type formed in the front face of the spherical silicon of the 1st conductivity type.
[0030]
[Embodiment of the Invention] Next, it explains to a detail, referring to a drawing about the gestalt of operation of this invention.
As shown in drawing 1, the photovoltaic cell 1 which consists of spherical silicon is made to interconnect in the solar battery of the 1st operation gestalt of operation gestalt 1 this invention through a bump 2 by every three perpendicular directions, and it comes to form the diode which constitutes the inverter circuit section 3 in the lower part of the spherical silicon of the lowest layer. And it is made to come to connect this solar battery with the mounting substrate 5 through the bump 4 for mounting formed in the lower part of the spherical silicon of the lowest layer.
[0031] On the other hand, the ground electrode 13 which consists of transparence electric conduction film which consists of indium oxide tin (ITO) so that this front face may be covered further while forming n mold polycrystalline silicon layer 12 in the front face of p mold single-crystal-silicon ball 11 with a diameter of 1mm and forming pn junction as the photovoltaic cell 1 which constitutes this solar battery shows an expanded sectional view to drawing 2 is formed. And while forming the becoming inside electrode 15 which consists of a chromium thin film so that p mold single-crystal-silicon ball 11 may be contacted, while a ground electrode 13 and n mold polycrystalline silicon layer 12 are removed and covering the front face of this clearance section with the oxidation silicone film 14 until this part reaches p mold single-crystal-silicon ball 11 by polish, bump 2a is formed in the front face. On the other hand, bump 2b is formed so that this bump may be contacted to the core of a ball in a symmetric position at a ground electrode 13.
[0032] Next, the manufacture approach of this photovoltaic cell 1 is explained. First, as shown in drawing 3 (a), while carrying out mirror polishing of the front face of p mold single-crystal-silicon ball 11 with a

diameter of 1mm, it washes and n mold polycrystalline silicon layer 12 is formed with the CVD method using mixed gas, such as a silane containing phosphoretted hydrogen. A CVD process can perform thin film formation here using equipment (it mentions later) as shown in drawing 4 by conveying the inside of the gas ambient atmosphere heated by desired reaction temperature.
[0033] Then, as shown in drawing 3 (b), the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0034] And a part of ground electrode 13 and n mold polycrystalline silicon layer 12 are removed until it reaches p mold single-crystal-silicon ball 11 by polish, as shown in drawing 3 (c).
[0035] And as shown in drawing 3 (d) after this, it covers with the oxidation silicone film 14 by heat-treating the front face of this clearance section in an oxygen ambient atmosphere. Since the oxidation rate is large on p mold polycrystalline silicon layer 12 which is a high-concentration impurity range at this time, the silicon oxide layer of the thickness which is about 2 times of p mold single-crystal-silicon ball 11 front face is formed.
[0036] By etching this without a mask, it is exposed of p mold single-crystal-silicon ball 11 in the thin field of the thickness of the silicon oxide layer 14. And as shown in drawing 3 (e), the becoming inside electrode 15 which consists of a chromium thin film is formed so that p mold single-crystal-silicon ball 11 may be contacted. When the process of drawing 3 (d) and drawing 3 (e) controls a type of gas and gas temperature within the transport device of drawing 4 similarly, it can form easily.
[0037] And finally, while forming bump 2a in the front face of this inside electrode 15, bump 2b is formed and a spherical photovoltaic cell as shown in drawing 2 is completed so that this bump may be contacted to the core of a ball in a symmetric position at a ground electrode 13.
[0038] Next, the CVD system for forming n mold polycrystalline silicon layer 12 used at the process shown in said drawing 3 (b) here is explained. As shown in drawing 4 (a) thru/or (c), a gas supply line 103 is minded from the source 104 of gas supply for CVD to the inner tube 102 constituted so that it could control by the heater 101 to desired temperature in the CVD section 100. A mono silane (SiH4), The reactant gas (the 1st reactant gas and ******) which comes to add the phosphoretted hydrogen as an impurity is supplied, and n mold polycrystalline silicon layer 12 is formed in the front face of p mold single-crystal-silicon ball 11 which passes through the inside of this inner tube 102 at the rate of predetermined by the pyrolysis. And the whorl style formation section 110 and the attraction blowdown section 120 which attracts the 1st reactant gas with a whorl style, By eliminating this 1st reactant gas from a silicon ball front face thoroughly by the ambient atmosphere converter which consisted of the sending-out sections 130 which impress the high voltage pulse of inert gas to p mold single-crystal-silicon ball 11, and are sent out, accelerating, and stopping membrane formation n mold polycrystalline silicon layer 12 in which thickness control was made by high degree of accuracy can be formed.
[0039] That is, it is equipment characterized by to be equipped this equipment with the ambient atmosphere conversion function which is contacted in p mold single-crystal-silicon ball 11 within the inner tube held at the temperature of a request of the 1st reactant gas, forms n mold polycrystalline-silicon layer 12 with a sufficient controllability, removes this 1st reactant gas and is sent out to the following down stream processing from this p mold single-crystal-silicon ball 11 with the 2nd carrier gas which consists of inert gas. Drawing 4 (b) and (c) are the A-A sectional views and B-B sectional views of drawing 4 (a) here, respectively.
[0040] Moreover, the inner tube 112 with which the whorl style formation section 110 consists of a Teflon pipe with a bore of about 2mm constituted so that a single-crystal-silicon ball might be made to pass with the 1st reactant gas from the feed hopper connected to the CVD section, The outer tube 113 with a bore of about 15mm arranged so that this inner tube 112 might be surrounded, The 1st conveyance way 114 formed between this outer tube 113 and said inner tube 112, It is arranged so that it may become point symmetry to Muraji through and a medial axis on said 1st conveyance way 114. it constitutes from two high pressure gas feed hoppers 115a and 115b which penetrate this outer wall in the outer wall of said outer tube 113, and supply high pressure gas to it from a tangential direction -- having -- **** -- high pressure gas feed hoppers 115a and 115b from -- by spouting inert gas It is constituted so that a whorl style may be formed in accordance with the tube wall of said inner tube 112.
[0041] Moreover, the attraction blowdown section 120 consists of blowdown rooms 122 of the shape of a cylinder which separated predetermined spacing, was arranged from the soffit of an inner tube 112, and was arranged in the surroundings of the recovery pipe 121 which consists of porosity tubing of path size rather than said inner tube, and this recovery pipe. The space of the blowdown room 122 interior which attracts and discharges this 1st reactant gas is connected with the recovery tank (not shown) cooled through piping by the recovery pump 124 and predetermined temperature as a decompression device from two or more discharge holes 123 arranged along with the periphery of a downstream.
[0042] Muraji through and the bore of the recovery pipe 121 correspond with said inner tube 112 mostly

with said inner tube 112, it is about 2mm, and an outer diameter is about 4mm. By changing the blowdown room 22 interior into a reduced pressure condition with this recovery pump 24 The single-crystal-silicon ball sent out with the gas (the 1st reactant gas and ******) which contains the reactant gas from said CVD system by the blowdown interior of a room being in a negative pressure condition to the interior of the recovery pipe 121 The whorl style rectified through the conveyance way 114 at the opening edge of said inner tube 112 is contacted, and while carrying out adiabatic expansion within the recovery pipe 121 of path size, it is efficiently discharged by the blowdown room 122 of the method of outside with a whorl style.

[0043] Moreover, this blowdown room 122 forms the taper side which spreads in the method of outside, and it consists of recovery pipes 121 at the downstream so that the 1st reactant gas discharged through the recovery pipe 121 may be discharged efficiently, though nothing [in a laminar flow] along with taper side 127T.

[0044] And it is collected by the recovery tank which is not illustrated with the recovery pump 124 through the discharge hole 123 arranged at the predetermined spacing along with the periphery near the down-stream edge of this blowdown room 122 as shown in drawing 4 (c).

[0045] Here, what was obtained by the approach of the porous material which constitutes a recovery pipe sintering the fine particles of a ceramic, resin, and a metal is used. Many breakthroughs are prepared in the side attachment wall of the recovery pipe 121 located in the blowdown room 22 interior of this.

[0046] Furthermore it connects with the exhaust pipe 125 which turns into said inner tube from the Teflon pipe of the diameter of the same mostly at down-stream one end of this recovery pipe 121, and this exhaust pipe 125 is accelerated and sent out by the 2nd carrier gas which consists of inert gas which is connected to the sending-out section 130 and spouted as a high voltage pulse here.

[0047] This sending-out section 130 possesses the acceleration tube 131 and the branch pipe 132, and the upper bed section of an acceleration tube 131 is connected with the exhaust pipe 125 through the joint tube 133. Here, the branching include angle theta is chosen so that a branch pipe 132 may be sent out at the rate of a request, the inert gas with which the 2nd carrier gas made the shape of a pulse, was supplied in the branch pipe 132, and was accelerated by the pulse generator 135 accelerating a single-crystal-silicon ball. Although it is not limited especially if this branching include angle theta can be accelerated, it is desirable that it is at least 45 degrees or less, and especially 30 degrees or less are desirable. It is because there is a possibility of said 2nd carrier gas flowing backwards and barring migration of a single-crystal-silicon ball in a joint tube when the branching include angle theta becomes larger than 45 degrees.

[0048] This CVD system can carry out desired thin film formation to high degree of accuracy efficiently extremely by non-contact.

[0049] In addition, you may make it form the barrier layer which becomes the interface of an electrode, a bump or an electrode, and a semi-conductor layer from a titanium nitride layer etc. if needed.

[0050] On the other hand, the inverter circuit section is formed by forming a circuit pattern and connecting with the solar-battery section according to a photolithography process, while forming diode.

[0051] Thus, a solar battery as showed the formed spherical semi-conductor cel to drawing 1 by connecting through a bump 4 on the substrate 5 for mounting is completed.

[0052] According to this configuration, since the inverter circuit formed in the spherical semi-conductor front face is connected to the spherical solar-battery section, it is small, and it becomes possible to offer the small solar battery of a component-side product.

[0053] In addition, the series connection of the photovoltaic cell may be carried out, and it may carry out parallel connection. In case a series connection is carried out, it is also possible to form a series-connection object by arranging by turns the cel which made p layers and n layers reverse by the outside surface and inner surface side, and connecting similarly.

[0054] The 2nd operation gestalt of this invention is explained to the secondary operation gestalt. In this solar battery, as shown in drawing 5 , it is characterized by coming to provide the spherical semiconductor integrated circuit section which comes to form the solar-battery section and the inverter circuit section 30 connected to this solar-battery section 10 through the isolation insulator layer 40 on one spherical silicon front face.

[0055] This inverter circuit section comes to form n mold diffusion layer 32 in this interior while forming p mold well field 31 in the component field surrounded by the component demarcation membrane 40. And an electrode 33 is formed and it is made to connect with a load. In addition, interconnect of the inverter circuit section and the solar-battery section is connected by the circuit pattern which was formed in the substrate front face and which is not illustrated.

[0056] On the occasion of manufacture, a photolithography process, the formation process of a component demarcation membrane, a membrane formation process, etc. can be formed within the

equipment similarly shown in drawing 4 according to said 1st operation gestalt.
[0057] According to this configuration, since the solar-battery section and an inverter circuit are provided on the same spherical semi-conductor front face, it becomes possible to offer a small and efficient power unit. Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.
[0058] The operation gestalt 3, next the 3rd operation gestalt of this invention are explained. The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type from this equipment at least as shown in drawing 6 , While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face, The logical circuit section formed in the spherical semi-conductor front face is provided, and the ground electrode of said spherical solar-battery section 1 and an inside electrode, and said spherical semiconductor integrated circuit 3 and said logical circuit section 6 interconnect through the bump 4.
[0059] It becomes since conversion into ac of the electromotive force acquired in the solar-battery section 1 can be carried out by the inverter circuit as it is and this can be directly used in the logical circuit section, when becoming possible to make a wire length small according to this configuration, mounting is also easy, and a component-side product is small, and possible to offer an efficient semiconductor device.
[0060] Although the operation gestalt 4, in addition said 1st operation gestalt explained the example by which cluster connection was made so that a spherule might make a three-tiered structure As shown in drawing 7 , said spherical solar-battery section 1, the spherical semiconductor integrated circuit section 3, and the logical circuit section 6 Cluster connection is made through bumps 4 and 2, and it is characterized by arranging said spherical solar-battery section to a front-face side so that it may be formed in the spherical substrate which became independent, respectively and two-layer structure may be made on mounting substrate 5 front face.
[0061] According to this configuration, in addition to the effectiveness by the operation gestalt of the above 1st, the front-face side which is easy to receive light considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the lower layer with small light income becomes able [a component-side product] to obtain a small more efficient semiconductor device.
[0062] the operation gestalt 5 -- with this operation gestalt, as shown in drawing 8 , said spherical solar-battery section 1, and the spherical semiconductor integrated circuit section 3 and the logical circuit section 6 are formed in the same spherical substrate, and said spherical solar-battery section is characterized by being arranged so that it may be located in the semi-sphere by the side of a front face.
[0063] According to this configuration, the front-face side which is easy to receive the light of a spherical semi-conductor considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the rear-face side where light income is small becomes possible [obtaining a small and more efficient semiconductor device].
[0064] the operation gestalt 6 -- with this operation gestalt , as show in drawing 9 , said spherical solar battery section 1 be characterize by provide the bump 2 who connect with a ground electrode and an inside electrode , respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carry out phase opposite , and carry out the series connection to it through each bump .
[0065] According to this configuration, it becomes possible to arrange many spherical solar batteries to high density most through a bump, and to connect. Moreover, positioning becomes easy, when arranging the solar-battery section more than two-layer and the space between the spherical semi-conductors by the bump can be used as photoconductive admission into a club.
[0066] the operation gestalt 7 -- as an expanded sectional view is shown in drawing 10 , while the photovoltaic cell 1 which constitutes this solar battery forms n mold amorphous silicon layer 51 and p mold amorphous silicon layer 52 in the front face of the copper ball 50 with a diameter of 1mm through barrier layer 50B which consists of chromium and titanium and forms pn junction -- further -- this front face -- a wrap -- the ground electrode 53 which consists of indium oxide tin (ITO) transparence electric conduction film like is formed. And a ground electrode 53 and p mold amorphous silicon layer 52, and n mold amorphous silicon layer 51 are removed until it reaches the barrier layer which this part becomes from chromium and titanium by polish, and bump 55a is formed and it becomes so that the barrier layer of

this clearance section may be contacted. On the other hand, to the core of this bump 55a and a ball, bump 55b is formed in the symmetric position so that a ground electrode 53 may be contacted.
[0067] Next, the manufacture approach of this photovoltaic cell 1 is explained. First, as shown in drawing 11 (a), while carrying out surface polish of the copper ball 50 with a diameter of 1mm, it washes and sequential formation of the barrier layer which consists of chromium and titanium is carried out with vacuum evaporation technique (drawing 11 (b)). This connects to the evaporation chamber having the evaporation source for vacuum deposition the gas supply line of the CVD section of the CVD system used with said 1st operation gestalt, and formation of the vacuum evaporationo film can form it, performing thickness control of high degree of accuracy by non-contact by contacting the steam containing the steam and titanium particle containing a chromium particle to a copper ball 50.
[0068] The rest forms n mold amorphous silicon layer 51 and p mold amorphous silicon layer 52 by the law using mixed gas, such as a silane containing phosphoretted hydrogen, like said 1st operation gestalt. A CVD process can perform thin film formation here using the equipment shown in drawing 4 by conveying the inside of the gas ambient atmosphere heated by desired reaction temperature (drawing 11 (c)).
[0069] Then, as shown in drawing 11 (d), the ITO thin film 53 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0070] And a part of ground electrode 53 and p mold amorphous silicon layer 52, and n mold amorphous silicon layer 51 are removed until it reaches a copper ball 50 or barrier layer 50B by polish, as shown in drawing 11 (e).
[0071] And as shown in drawing 11 (f) after this, bump 55a is formed in this removed copper ball 50 of a part or barrier layer 50B front face. In this case, direct bump 55a can be formed in a copper ball 50 or barrier layer 50B. Moreover, the solar battery which formed bump 55b also on the ground electrode, and was shown in drawing 10 is completed.
[0072] Thus, the solar-battery equipment which fixed two formed solar batteries is shown in drawing 12 . Here, after fixing Bumps 55a and 55b, carrying out heating fusion and joining together electrically, while fixing a bump's surroundings with the insulating adhesives 56 and raising bond strength, it becomes possible to aim at a surrounding electric insulation.
[0073] the operation gestalt 8 -- the photovoltaic cell which constitutes this solar battery is characterized by constituting a spherical substrate from an insulating spherule, forming in this spherical body surface n mold amorphous silicon layer and the amorphous silicon layer of p mold formed in said n type of amorphous silicon layer front face, and coming to form pn junction.
[0074] The ground electrode 63 which consists [as an expanded sectional view is shown in drawing 13 ,] of indium oxide tin (ITO) transparence electric conduction film so that this front face may be covered further while this photovoltaic cell forms chromium layer 60c in the front face of glass 60 with a diameter of 1mm, and forming n mold amorphous silicon layer 61 and p mold amorphous silicon layer 62 in this upper layer and forming pn junction is formed. And a ground electrode 63 and p mold amorphous silicon layer 62, and n mold amorphous silicon layer 61 are removed until this part reaches chromium layer 60c by polish, and bump 65a is formed and it becomes so that the barrier layer of this clearance section may be contacted. On the other hand, to the core of this bump 65a and a ball, bump 65b is formed in the symmetric position so that a ground electrode 63 may be contacted.
[0075] According to this configuration, it becomes it is cheap and possible to obtain the semiconductor device whose property was stable.
[0076] In addition, although the amorphous silicon was used with the gestalt of said operation as a semi-conductor layer which forms pn junction, it can apply to a polycrystalline silicon layer or a single-crystal-silicon layer, and a pan also at compound semiconductor layers, such as GaAs and GaP, without being limited to this. Furthermore, it is applicable not only to pn structure but pin structure.
[0077] Since it is possible to connect and line-ize each down stream processing on the occasion of manufacture of this spherical semiconductor device, there is the description that productivity is very high.
[0078] At each process, processing in the various ambient atmospheres not only containing gases, such as activated gas and inert gas, but liquids, such as water and various solutions, is made. When connecting such down stream processing, in order to have to make it not have to bring the ambient atmosphere which conveys a processed material to an after process from a before process, Although the ambient atmosphere of a before process is removed from a processed material between processes and the activity of changing into the ambient atmosphere doubled with the after process, and conveying a processed material is required Each down stream processing can be performed conveying by using an ambient atmosphere inverter as shown in drawing 4 , and it becomes possible extremely to offer a reliable semiconductor device with sufficient workability at high speed.
[0079] Moreover, although a silicon front face also has problems, like contact nature with the metal-electrode layer formed in the upper layer worsens when it is easy to oxidize and the natural oxidation film

is formed in a front face, conveyance and processing can be performed in closeout space, without contacting the open air.

[0080]

[Effect of the Invention] Since the solar-battery section and an inverter circuit are provided on the spherical semi-conductor front face according to this invention as explained above, it becomes possible to offer a small and efficient power unit.

[0081] Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the semiconductor device which used a solar battery and this, and relates to the structure of the solar battery especially using a spherical semi-conductor.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The electron and electron hole which were generated when the internal field has arisen into the pn junction part of a semi-conductor, light is applied to this and the electron-hole pair was made to generate are separated by the internal field, an electron is brought together in the n side, an electron hole is brought together in the p side, and if a load is connected outside, a current will flow towards the n side from the p side. This effectiveness is used and utilization of a solar battery is advanced as a component which transforms light energy into electrical energy.
[0003] In recent years, the technique of forming a circuit pattern on a spherical semi-conductor (Ball Semiconductor) with a diameter [of single crystal silicon etc.] of 1mm or less, and manufacturing a semiconductor device is developed.
[0004] The manufacture approach of the solar array which connected many semi-conductor particles, using aluminum foil as one is proposed (JP,6-13633,A). By this approach, as shown in drawing 14 , the semi-conductor particle 207 which has the 1st conductivity-type epidermis section and the interior of the 2nd conductivity type is arranged so that it may project from the both sides of aluminum foil 201 in opening of aluminum foil, the epidermis section 209 of one side is removed, and an insulating layer 221 is formed. Next, the part inside [111] the 2nd conductivity type and the insulating layer 221 on it are removed, and the 2nd aluminum foil 219 is combined with the removed field 217. The flat field 217 offers good ohmic contact to the 2nd aluminum foil 219 as a current carrying part.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since the solar-battery section and an inverter circuit are provided on the spherical semi-conductor front face according to this invention as explained above, it becomes possible to offer a small and efficient power unit.
[0081] Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, by such approach, since there is a limitation in high density arrangement and aluminum foil will exist in the shape of a field, the light to a lower layer will be intercepted with this aluminum foil. Therefore, the semi-conductor particle used as a photoelectrical converter cannot carry out a deer array further, and had become the problem which obstructs that the electromotive force per unit area improves.
[0006] Moreover, although the inverter circuit which changes a direct current into an alternating current was required for such a solar battery, since it connected with a solar battery through aluminum foil 219, this inverter circuit had a long wiring distance, and in order to have to prepare as another semiconductor chip, it had become the problem which obstructs the miniaturization of equipment.
[0007] Even if it faced connection with a logical circuit chip, the wire length to the logical circuit chip driven with this electromotive force became large, and had caused various problems, such as generating of parasitic capacitance, from the ejection terminal of the electromotive force from a solar battery further again.
[0008] This invention was made in view of said actual condition, and aims to let manufacture offer the easy and possible solar battery of a miniaturization. Moreover, this invention aims at offering a scale and an efficient solar battery for improvement in the electromotive force per unit area. This invention possesses a generation-of-electrical-energy function, and aims at offering a small and efficient semiconductor device further again.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] The semi-conductor layer of the 2nd conductivity type formed so that the 1st solar battery of this invention might form pn junction in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face are provided. The ground electrode and inside electrode of said spherical solar-battery section, Said spherical semiconductor integrated circuit is characterized by interconnecting.
[0010] According to this configuration, since the inverter circuit formed in the spherical semi-conductor front face is connected to the spherical solar-battery section, it is small, and it becomes possible to offer the small solar battery of a component-side product.
[0011] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 2nd of this invention, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type It is characterized by coming to provide the spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which interconnects on said spherical semi-conductor front face with said solar-battery section, and comes to form an inverter circuit in it.
[0012] According to this configuration, since the solar-battery section and an inverter circuit are provided on the same spherical semi-conductor front face, it becomes possible to offer a small and efficient power unit. Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.
[0013] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 3rd of this invention, While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face, The logical circuit section formed in the spherical semi-conductor front face is provided, and the ground electrode of said spherical solar-battery section and an inside electrode, and said spherical semiconductor integrated circuit and said logical circuit section are characterized by interconnecting through a bump.
[0014] It becomes since the electromotive force acquired in the solar-battery section can be directly used in the logical circuit section as it is according to this configuration, when becoming possible to make a wire length small, mounting is also easy, and a component-side product is small, and possible to offer an efficient semiconductor device.
[0015] According to the 4th of this invention, in a semiconductor device according to claim 3, cluster connection is made through a bump and said spherical solar-battery section is characterized by being arranged at the front-face side so that said spherical solar-battery section, the spherical semiconductor integrated circuit section, and the logical circuit section may be formed in the spherical substrate which became independent, respectively and two or more layer structure may be made on a mounting substrate

front face.
[0016] According to this configuration, in addition to the effectiveness by the above 4th, the front-face side which is easy to receive light considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the lower layer with small light income becomes able [a component-side product] to obtain a small more efficient semiconductor device.
[0017] According to the 5th of this invention, in a semiconductor device according to claim 4, said spherical solar-battery section, and the spherical semiconductor integrated circuit section or the logical circuit section is formed in the same spherical substrate, and said spherical solar-battery section is characterized by being arranged so that it may be located in the semi-sphere by the side of a front face.
[0018] According to this configuration, in addition to the effectiveness by the above 4th, the front-face side which is easy to receive the light of a spherical semi-conductor considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the rear-face side where light income is small becomes possible [obtaining a small and more efficient semiconductor device].
[0019] According to the 6th of this invention, in a semiconductor device according to claim 3 to 5, said spherical solar-battery section is characterized by providing the bump who connects with a ground electrode and an inside electrode, respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carries out phase opposite, and carrying out the series connection to it through each bump.
[0020] According to this configuration, it becomes possible to arrange many spherical solar batteries to high density most through a bump, and to connect. Moreover, positioning becomes easy, when arranging the solar-battery section more than two-layer and the space between the spherical semi-conductors by the bump can be used as photoconductive admission into a club.
[0021] According to the 7th of this invention, in a semiconductor device according to claim 3 to 6, said spherical substrate consists of a silicon ball of the 1st conductivity type, and is characterized by coming to form pn junction between the amorphous silicon layers of the 2nd conductivity type formed in the front face of said silicon ball.
[0022] According to this configuration, the approach of whether the amorphous silicon layer of the 2nd conductivity type is deposited on a silicon ball front face and the paddle gap which forms an impurity diffused layer by diffusion enables it very easily to offer a semiconductor device with a large component area.
[0023] According to the 8th of this invention, in a semiconductor device according to claim 3 to 6, it is characterized by said spherical substrate consisting of a metal spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[0024] Since the semi-conductor layer which has pn junction is formed in a front face according to this configuration, using a metal spherule as a base, in order that this metal spherule may play the role of the charge collector of low resistance, it becomes it is very efficient and possible by using the good metal of ohmic contact nature to a semi-conductor layer to plan ejection of electromotive force. You may make it make a barrier layer intervene if needed.
[0025] According to the 9th of this invention, in a semiconductor device according to claim 3 to 6, it is characterized by said spherical substrate consisting of an insulating spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[0026] According to this configuration, it becomes it is cheap and possible to obtain the semiconductor device whose property was stable.
[0027] According to the 10th of this invention, in a semiconductor device according to claim 8, it is characterized by said 1st and 2nd silicon layers being amorphous silicon layers.
[0028] According to this configuration, an amorphous silicon layer can be formed also in an insulating substrate front face as film of high quality, and its property as a solar battery is also good.
[0029] According to the 11th of this invention, in a semiconductor device according to claim 3 to 6, said spherical solar-battery section is characterized by being the thing which comes to form pn junction between the impurity diffused layers of the 2nd conductivity type formed in the front face of the spherical silicon of the 1st conductivity type.
[0030]
[Embodiment of the Invention] Next, it explains to a detail, referring to a drawing about the gestalt of operation of this invention.
As shown in drawing 1, the photovoltaic cell 1 which consists of spherical silicon is made to interconnect in the solar battery of the 1st operation gestalt of operation gestalt 1 this invention through a bump 2 by

every three perpendicular directions, and it comes to form the diode which constitutes the inverter circuit section 3 in the lower part of the spherical silicon of the lowest layer. And it is made to come to connect this solar battery with the mounting substrate 5 through the bump 4 for mounting formed in the lower part of the spherical silicon of the lowest layer.

[0031] On the other hand, the ground electrode 13 which consists of transparence electric conduction film which consists of indium oxide tin (ITO) so that this front face may be covered further while forming n mold polycrystalline silicon layer 12 in the front face of p mold single-crystal-silicon ball 11 with a diameter of 1mm and forming pn junction as the photovoltaic cell 1 which constitutes this solar battery shows an expanded sectional view to drawing 2 is formed. And while forming the becoming inside electrode 15 which consists of a chromium thin film so that p mold single-crystal-silicon ball 11 may be contacted, while a ground electrode 13 and n mold polycrystalline silicon layer 12 are removed and covering the front face of this clearance section with the oxidation silicone film 14 until this part reaches p mold single-crystal-silicon ball 11 by polish, bump 2a is formed in the front face. On the other hand, bump 2b is formed so that this bump may be contacted to the core of a ball in a symmetric position at a ground electrode 13.

[0032] Next, the manufacture approach of this photovoltaic cell 1 is explained. First, as shown in drawing 3 (a), while carrying out mirror polishing of the front face of p mold single-crystal-silicon ball 11 with a diameter of 1mm, it washes and n mold polycrystalline silicon layer 12 is formed with the CVD method using mixed gas, such as a silane containing phosphoretted hydrogen. A CVD process can perform thin film formation here using equipment (it mentions later) as shown in drawing 4 by conveying the inside of the gas ambient atmosphere heated by desired reaction temperature.

[0033] Then, as shown in drawing 3 (b), the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.

[0034] And a part of ground electrode 13 and n mold polycrystalline silicon layer 12 are removed until it reaches p mold single-crystal-silicon ball 11 by polish, as shown in drawing 3 (c).

[0035] And as shown in drawing 3 (d) after this, it covers with the oxidation silicone film 14 by heat-treating the front face of this clearance section in an oxygen ambient atmosphere. Since the oxidation rate is large on p mold polycrystalline silicon layer 12 which is a high-concentration impurity range at this time, the silicon oxide layer of the thickness which is about 2 times of p mold single-crystal-silicon ball 11 front face is formed.

[0036] By etching this without a mask, it is exposed of p mold single-crystal-silicon ball 11 in the thin field of the thickness of the silicon oxide layer 14. And as shown in drawing 3 (e), the becoming inside electrode 15 which consists of a chromium thin film is formed so that p mold single-crystal-silicon ball 11 may be contacted. When the process of drawing 3 (d) and drawing 3 (e) controls a type of gas and gas temperature within the transport device of drawing 4 similarly, it can form easily.

[0037] And finally, while forming bump 2a in the front face of this inside electrode 15, bump 2b is formed and a spherical photovoltaic cell as shown in drawing 2 is completed so that this bump may be contacted to the core of a ball in a symmetric position at a ground electrode 13.

[0038] Next, the CVD system for forming n mold polycrystalline silicon layer 12 used at the process shown in said drawing 3 (b) here is explained. As shown in drawing 4 (a) thru/or (c), a gas supply line 103 is minded from the source 104 of gas supply for CVD to the inner tube 102 constituted so that it could control by the heater 101 to desired temperature in the CVD section 100. A mono silane (SiH4), The reactant gas (the 1st reactant gas and ******) which comes to add the phosphoretted hydrogen as an impurity is supplied, and n mold polycrystalline silicon layer 12 is formed in the front face of p mold single-crystal-silicon ball 11 which passes through the inside of this inner tube 102 at the rate of predetermined by the pyrolysis. And the whorl style formation section 110 and the attraction blowdown section 120 which attracts the 1st reactant gas with a whorl style, By eliminating this 1st reactant gas from a silicon ball front face thoroughly by the ambient atmosphere converter which consisted of the sending-out sections 130 which impress the high voltage pulse of inert gas to p mold single-crystal-silicon ball 11, and are sent out, accelerating, and stopping membrane formation n mold polycrystalline silicon layer 12 in which thickness control was made by high degree of accuracy can be formed.

[0039] That is, it is equipment characterized by to be equipped this equipment with the ambient atmosphere conversion function which is contacted in p mold single-crystal-silicon ball 11 within the inner tube held at the temperature of a request of the 1st reactant gas, forms n mold polycrystalline-silicon layer 12 with a sufficient controllability, removes this 1st reactant gas and is sent out to the following down stream processing from this p mold single-crystal-silicon ball 11 with the 2nd carrier gas which consists of inert gas. Drawing 4 (b) and (c) are the A-A sectional views and B-B sectional views of drawing 4 (a) here, respectively.

[0040] Moreover, the inner tube 112 with which the whorl style formation section 110 consists of a Teflon

pipe with a bore of about 2mm constituted so that a single-crystal-silicon ball might be made to pass with the 1st reactant gas from the feed hopper connected to the CVD section, The outer tube 113 with a bore of about 15mm arranged so that this inner tube 112 might be surrounded, The 1st conveyance way 114 formed between this outer tube 113 and said inner tube 112, It is arranged so that it may become point symmetry to Muraji through and a medial axis on said 1st conveyance way 114. it constitutes from two high pressure gas feed hoppers 115a and 115b which penetrate this outer wall in the outer wall of said outer tube 113, and supply high pressure gas to it from a tangential direction -- having -- **** -- high pressure gas feed hoppers 115a and 115b from -- by spouting inert gas It is constituted so that a whorl style may be formed in accordance with the tube wall of said inner tube 112.

[0041] Moreover, the attraction blowdown section 120 consists of blowdown rooms 122 of the shape of a cylinder which separated predetermined spacing, was arranged from the soffit of an inner tube 112, and was arranged in the surroundings of the recovery pipe 121 which consists of porosity tubing of path size rather than said inner tube, and this recovery pipe. The space of the blowdown room 122 interior which attracts and discharges this 1st reactant gas is connected with the recovery tank (not shown) cooled through piping by the recovery pump 124 and predetermined temperature as a decompression device from two or more discharge holes 123 arranged along with the periphery of a downstream.

[0042] Muraji through and the bore of the recovery pipe 121 correspond with said inner tube 112 mostly with said inner tube 112, it is about 2mm, and an outer diameter is about 4mm. By changing the blowdown room 22 interior into a reduced pressure condition with this recovery pump 24 The single-crystal-silicon ball sent out with the gas (the 1st reactant gas and ******) which contains the reactant gas from said CVD system by the blowdown interior of a room being in a negative pressure condition to the interior of the recovery pipe 121 The whorl style rectified through the conveyance way 114 at the opening edge of said inner tube 112 is contacted, and while carrying out adiabatic expansion within the recovery pipe 121 of path size, it is efficiently discharged by the blowdown room 122 of the method of outside with a whorl style.

[0043] Moreover, this blowdown room 122 forms the taper side which spreads in the method of outside, and it consists of recovery pipes 121 at the downstream so that the 1st reactant gas discharged through the recovery pipe 121 may be discharged efficiently, though nothing [in a laminar flow] along with taper side 127T.

[0044] And it is collected by the recovery tank which is not illustrated with the recovery pump 124 through the discharge hole 123 arranged at the predetermined spacing along with the periphery near the down-stream edge of this blowdown room 122 as shown in drawing 4 (c).

[0045] Here, what was obtained by the approach of the porous material which constitutes a recovery pipe sintering the fine particles of a ceramic, resin, and a metal is used. Many breakthroughs are prepared in the side attachment wall of the recovery pipe 121 located in the blowdown room 22 interior of this.

[0046] Furthermore it connects with the exhaust pipe 125 which turns into said inner tube from the Teflon pipe of the diameter of the same mostly at down-stream one end of this recovery pipe 121, and this exhaust pipe 125 is accelerated and sent out by the 2nd carrier gas which consists of inert gas which is connected to the sending-out section 130 and spouted as a high voltage pulse here.

[0047] This sending-out section 130 possesses the acceleration tube 131 and the branch pipe 132, and the upper bed section of an acceleration tube 131 is connected with the exhaust pipe 125 through the joint tube 133. Here, the branching include angle theta is chosen so that a branch pipe 132 may be sent out at the rate of a request, the inert gas with which the 2nd carrier gas made the shape of a pulse, was supplied in the branch pipe 132, and was accelerated by the pulse generator 135 accelerating a single-crystal-silicon ball. Although it is not limited especially if this branching include angle theta can be accelerated, it is desirable that it is at least 45 degrees or less, and especially 30 degrees or less are desirable. It is because there is a possibility of said 2nd carrier gas flowing backwards and barring migration of a single-crystal-silicon ball in a joint tube when the branching include angle theta becomes larger than 45 degrees.

[0048] This CVD system can carry out desired thin film formation to high degree of accuracy efficiently extremely by non-contact.

[0049] In addition, you may make it form the barrier layer which becomes the interface of an electrode, a bump or an electrode, and a semi-conductor layer from a titanium nitride layer etc. if needed.

[0050] On the other hand, the inverter circuit section is formed by forming a circuit pattern and connecting with the solar-battery section according to a photolithography process, while forming diode.

[0051] Thus, a solar battery as showed the formed spherical semi-conductor cel to drawing 1 by connecting through a bump 4 on the substrate 5 for mounting is completed.

[0052] According to this configuration, since the inverter circuit formed in the spherical semi-conductor front face is connected to the spherical solar-battery section, it is small, and it becomes possible to offer

the small solar battery of a component-side product.
[0053] In addition, the series connection of the photovoltaic cell may be carried out, and it may carry out parallel connection. In case a series connection is carried out, it is also possible to form a series-connection object by arranging by turns the cel which made p layers and n layers reverse by the outside surface and inner surface side, and connecting similarly.
[0054] The 2nd operation gestalt of this invention is explained to the secondary operation gestalt. In this solar battery, as shown in drawing 5 , it is characterized by coming to provide the spherical semiconductor integrated circuit section which comes to form the solar-battery section and the inverter circuit section 30 connected to this solar-battery section 10 through the isolation insulator layer 40 on one spherical silicon front face.
[0055] This inverter circuit section comes to form n mold diffusion layer 32 in this interior while forming p mold well field 31 in the component field surrounded by the component demarcation membrane 40. And an electrode 33 is formed and it is made to connect with a load. In addition, interconnect of the inverter circuit section and the solar-battery section is connected by the circuit pattern which was formed in the substrate front face and which is not illustrated.
[0056] On the occasion of manufacture, a photolithography process, the formation process of a component demarcation membrane, a membrane formation process, etc. can be formed within the equipment similarly shown in drawing 4 according to said 1st operation gestalt.
[0057] According to this configuration, since the solar-battery section and an inverter circuit are provided on the same spherical semi-conductor front face, it becomes possible to offer a small and efficient power unit. Moreover, the rear-face section with small light income becomes possible [obtaining a more efficient solar battery] by constituting an inverter circuit by the surface section which is easy to receive light with one spherical semi-conductor considering as the solar-battery section.
[0058] The operation gestalt 3, next the 3rd operation gestalt of this invention are explained. The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type from this equipment at least as shown in drawing 6 , While connecting with the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section which comes to provide the inside electrode sent for the front face, and the spherical semiconductor integrated circuit section which comes to form an inverter circuit in a spherical semi-conductor front face, The logical circuit section formed in the spherical semi-conductor front face is provided, and the ground electrode of said spherical solar-battery section 1 and an inside electrode, and said spherical semiconductor integrated circuit 3 and said logical circuit section 6 interconnect through the bump 4.
[0059] It becomes since conversion into ac of the electromotive force acquired in the solar-battery section 1 can be carried out by the inverter circuit as it is and this can be directly used in the logical circuit section, when becoming possible to make a wire length small according to this configuration, mounting is also easy, and a component-side product is small, and possible to offer an efficient semiconductor device.
[0060] Although the operation gestalt 4, in addition said 1st operation gestalt explained the example by which cluster connection was made so that a spherule might make a three-tiered structure As shown in drawing 7 , said spherical solar-battery section 1, the spherical semiconductor integrated circuit section 3, and the logical circuit section 6 Cluster connection is made through bumps 4 and 2, and it is characterized by arranging said spherical solar-battery section to a front-face side so that it may be formed in the spherical substrate which became independent, respectively and two-layer structure may be made on mounting substrate 5 front face.
[0061] According to this configuration, in addition to the effectiveness by the operation gestalt of the above 1st, the front-face side which is easy to receive light considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the lower layer with small light income becomes able [a component-side product] to obtain a small more efficient semiconductor device.
[0062] the operation gestalt 5 -- with this operation gestalt, as shown in drawing 8 , said spherical solar-battery section 1, and the spherical semiconductor integrated circuit section 3 and the logical circuit section 6 are formed in the same spherical substrate, and said spherical solar-battery section is characterized by being arranged so that it may be located in the semi-sphere by the side of a front face.
[0063] According to this configuration, the front-face side which is easy to receive the light of a spherical semi-conductor considers as the solar-battery section, and since he is trying to constitute an inverter circuit or the logical circuit section, the rear-face side where light income is small becomes possible [obtaining a small and more efficient semiconductor device].

[0064] the operation gestalt 6 -- with this operation gestalt , as show in drawing 9 , said spherical solar battery section 1 be characterize by provide the bump 2 who connect with a ground electrode and an inside electrode , respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carry out phase opposite , and carry out the series connection to it through each bump .
[0065] According to this configuration, it becomes possible to arrange many spherical solar batteries to high density most through a bump, and to connect. Moreover, positioning becomes easy, when arranging the solar-battery section more than two-layer and the space between the spherical semi-conductors by the bump can be used as photoconductive admission into a club.
[0066] the operation gestalt 7 -- as an expanded sectional view is shown in drawing 10 , while the photovoltaic cell 1 which constitutes this solar battery forms n mold amorphous silicon layer 51 and p mold amorphous silicon layer 52 in the front face of the copper ball 50 with a diameter of 1mm through barrier layer 50B which consists of chromium and titanium and forms pn junction -- further -- this front face -- a wrap -- the ground electrode 53 which consists of indium oxide tin (ITO) transparence electric conduction film like is formed. And a ground electrode 53 and p mold amorphous silicon layer 52, and n mold amorphous silicon layer 51 are removed until it reaches the barrier layer which this part becomes from chromium and titanium by polish, and bump 55a is formed and it becomes so that the barrier layer of this clearance section may be contacted. On the other hand, to the core of this bump 55a and a ball, bump 55b is formed in the symmetric position so that a ground electrode 53 may be contacted.
[0067] Next, the manufacture approach of this photovoltaic cell 1 is explained. First, as shown in drawing 11 (a), while carrying out surface polish of the copper ball 50 with a diameter of 1mm, it washes and sequential formation of the barrier layer which consists of chromium and titanium is carried out with vacuum evaporation technique (drawing 11 (b)). This connects to the evaporation chamber having the evaporation source for vacuum deposition the gas supply line of the CVD section of the CVD system used with said 1st operation gestalt, and formation of the vacuum evaporationo film can form it, performing thickness control of high degree of accuracy by non-contact by contacting the steam containing the steam and titanium particle containing a chromium particle to a copper ball 50.
[0068] The rest forms n mold amorphous silicon layer 51 and p mold amorphous silicon layer 52 by the law using mixed gas, such as a silane containing phosphoretted hydrogen, like said 1st operation gestalt. A CVD process can perform thin film formation here using the equipment shown in drawing 4 by conveying the inside of the gas ambient atmosphere heated by desired reaction temperature (drawing 11 (c)).
[0069] Then, as shown in drawing 11 (d), the ITO thin film 53 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0070] And a part of ground electrode 53 and p mold amorphous silicon layer 52, and n mold amorphous silicon layer 51 are removed until it reaches a copper ball 50 or barrier layer 50B by polish, as shown in drawing 11 (e).
[0071] And as shown in drawing 11 (f) after this, bump 55a is formed in this removed copper ball 50 of a part or barrier layer 50B front face. In this case, direct bump 55a can be formed in a copper ball 50 or barrier layer 50B. Moreover, the solar battery which formed bump 55b also on the ground electrode, and was shown in drawing 10 is completed.
[0072] Thus, the solar-battery equipment which fixed two formed solar batteries is shown in drawing 12 . Here, after fixing Bumps 55a and 55b, carrying out heating fusion and joining together electrically, while fixing a bump's surroundings with the insulating adhesives 56 and raising bond strength, it becomes possible to aim at a surrounding electric insulation.
[0073] the operation gestalt 8 -- the photovoltaic cell which constitutes this solar battery is characterized by constituting a spherical substrate from an insulating spherule, forming in this spherical body surface n mold amorphous silicon layer and the amorphous silicon layer of p mold formed in said n type of amorphous silicon layer front face, and coming to form pn junction.
[0074] The ground electrode 63 which consists [as an expanded sectional view is shown in drawing 13 ,] of indium oxide tin (ITO) transparence electric conduction film so that this front face may be covered further while this photovoltaic cell forms chromium layer 60c in the front face of glass 60 with a diameter of 1mm, and forming n mold amorphous silicon layer 61 and p mold amorphous silicon layer 62 in this upper layer and forming pn junction is formed. And a ground electrode 63 and p mold amorphous silicon layer 62, and n mold amorphous silicon layer 61 are removed until this part reaches chromium layer 60c by polish, and bump 65a is formed and it becomes so that the barrier layer of this clearance section may be contacted. On the other hand, to the core of this bump 65a and a ball, bump 65b is formed in the symmetric position so that a ground electrode 63 may be contacted.
[0075] According to this configuration, it becomes it is cheap and possible to obtain the semiconductor device whose property was stable.

[0076] In addition, although the amorphous silicon was used with the gestalt of said operation as a semiconductor layer which forms pn junction, it can apply to a polycrystalline silicon layer or a single-crystal-silicon layer, and a pan also at compound semiconductor layers, such as GaAs and GaP, without being limited to this. Furthermore, it is applicable not only to pn structure but pin structure.
[0077] Since it is possible to connect and line-ize each down stream processing on the occasion of manufacture of this spherical semiconductor device, there is the description that productivity is very high.
[0078] At each process, processing in the various ambient atmospheres not only containing gases, such as activated gas and inert gas, but liquids, such as water and various solutions, is made. When connecting such down stream processing, in order to have to make it not have to bring the ambient atmosphere which conveys a processed material to an after process from a before process, Although the ambient atmosphere of a before process is removed from a processed material between processes and the activity of changing into the ambient atmosphere doubled with the after process, and conveying a processed material is required Each down stream processing can be performed conveying by using an ambient atmosphere inverter as shown in drawing 4 , and it becomes possible extremely to offer a reliable semiconductor device with sufficient workability at high speed.
[0079] Moreover, although a silicon front face also has problems, like contact nature with the metal-electrode layer formed in the upper layer worsens when it is easy to oxidize and the natural oxidation film is formed in a front face, conveyance and processing can be performed in closeout space, without contacting the open air.

[Translation done.]

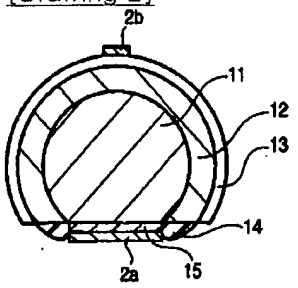
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the solar battery of the 1st operation gestalt of this invention
[Drawing 2] The sectional view of the cel which constitutes the solar battery of the 1st operation gestalt of this invention
[Drawing 3] Production process drawing of the cel which constitutes the solar battery of the 1st operation gestalt of this invention
[Drawing 4] Drawing showing the manufacturing installation for manufacturing the solar battery of the 1st operation gestalt of this invention
[Drawing 5] The sectional view of the cel which constitutes the solar battery of the 2nd operation gestalt of this invention
[Drawing 6] Drawing showing the solar battery of the 3rd operation gestalt of this invention
[Drawing 7] Drawing showing the solar battery of the 4th operation gestalt of this invention
[Drawing 8] Drawing showing the solar battery of the 5th operation gestalt of this invention
[Drawing 9] Drawing showing the solar battery of the 6th operation gestalt of this invention
[Drawing 10] The sectional view of the cel which constitutes the solar battery of the 7th operation gestalt of this invention
[Drawing 11] Production process drawing of the cel which constitutes the solar battery of the 7th operation gestalt of this invention
[Drawing 12] Drawing showing the solar battery of the 7th operation gestalt of this invention
[Drawing 13] The sectional view of the cel which constitutes the solar battery of the 8th operation gestalt of this invention
[Drawing 14] Drawing showing the solar battery of the conventional example
[Description of Notations]
1 Solar Battery
2 Bump
3 Inverter Circuit Section
4 Bump
5 Mounting Substrate
6 Logical Circuit Section
11 P Mold Single-Crystal-Silicon Ball
12 N Mold Polycrystalline Silicon Layer
13 Ground Electrode
14 Insulator Layer
15 Inside Electrode
2a, 2b Bump

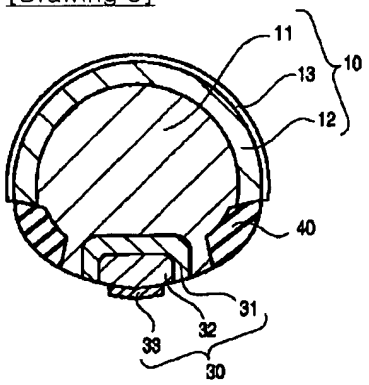
[Translation done.]

DRAWINGS

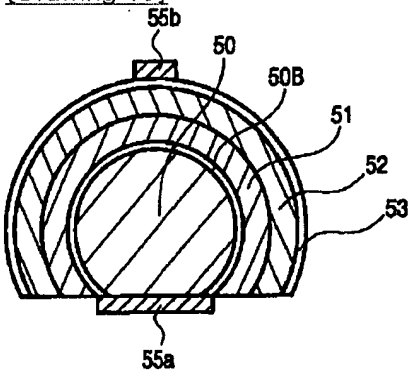
[Drawing 2]



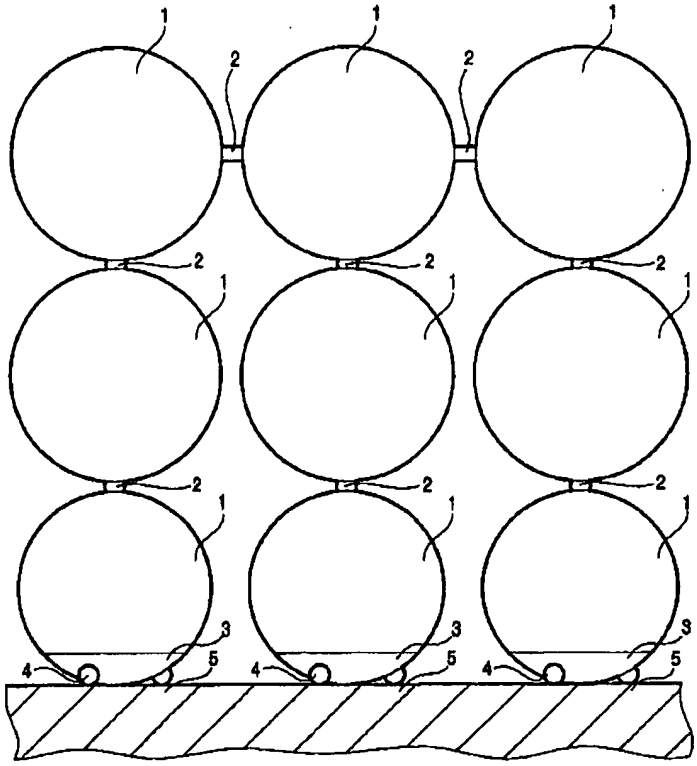
[Drawing 5]



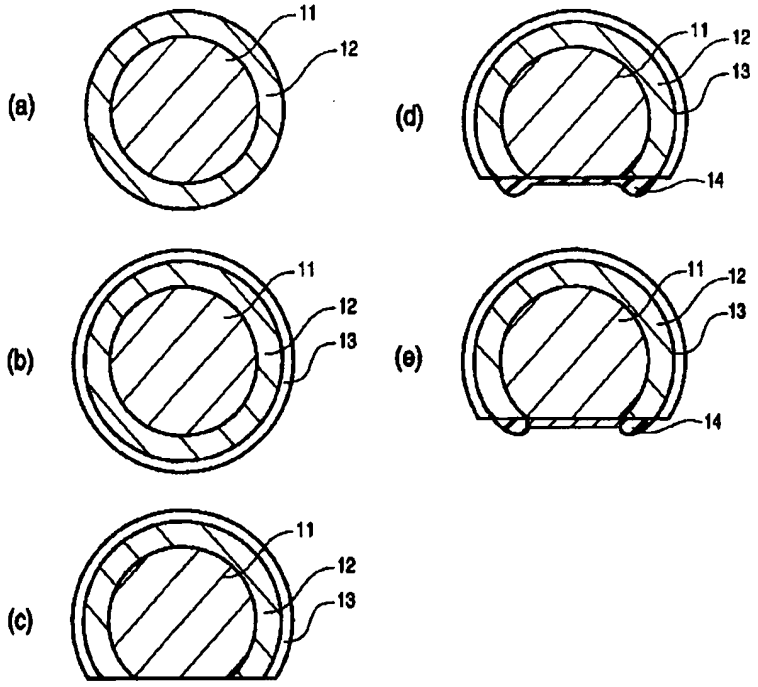
[Drawing 10]



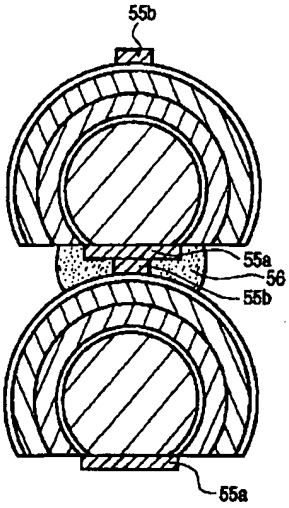
[Drawing 1]



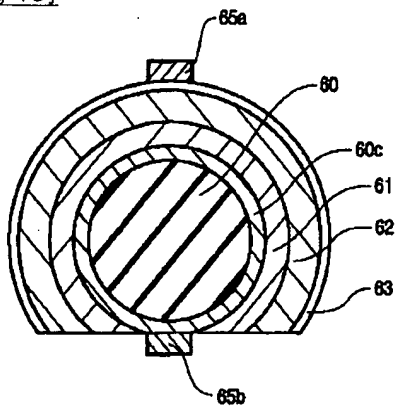
[Drawing 3]



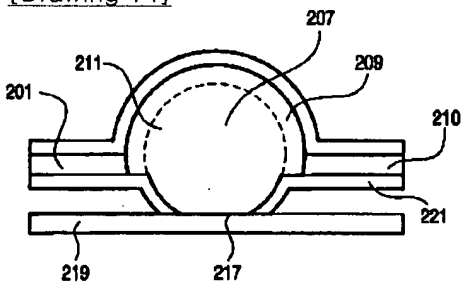
[Drawing 12]



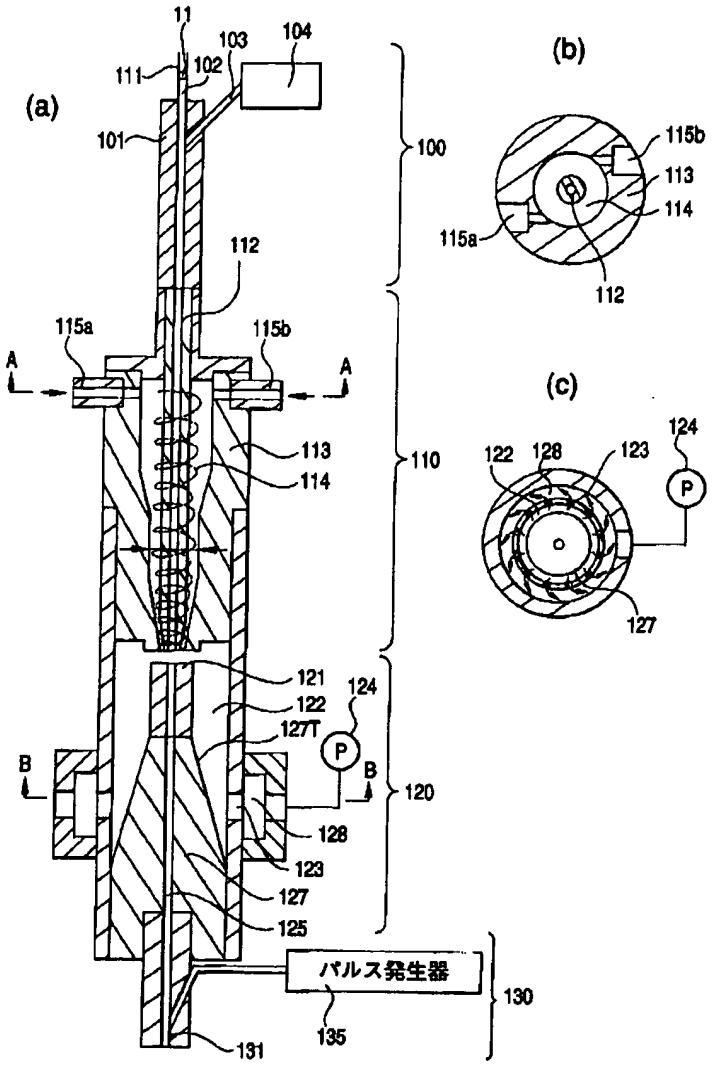
[Drawing 13]



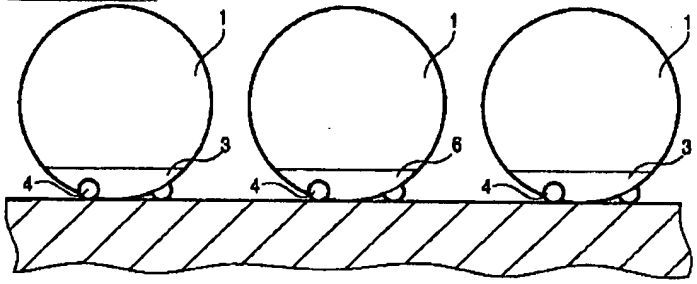
[Drawing 14]



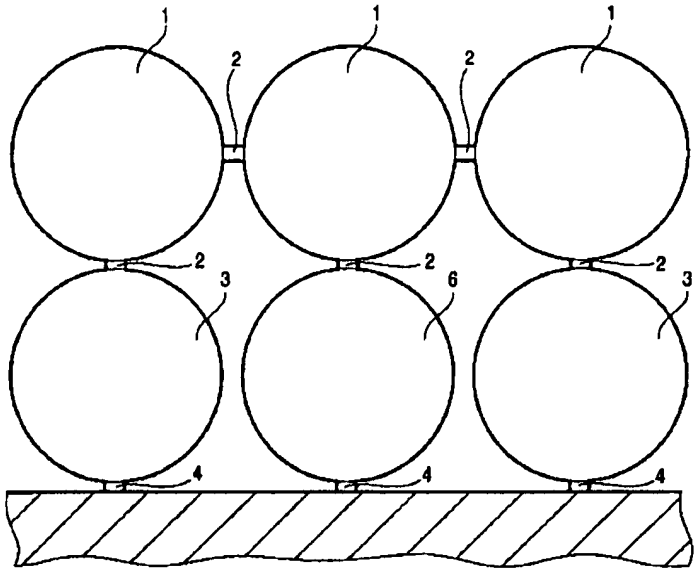
[Drawing 4]



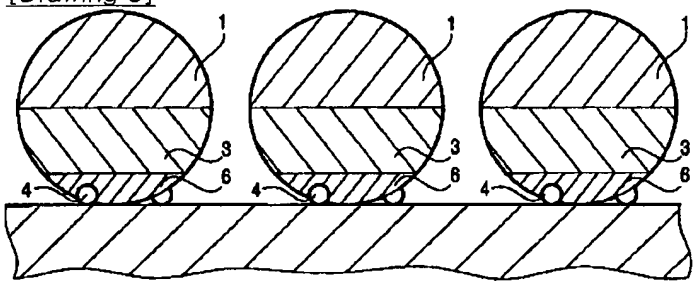
[Drawing 6]



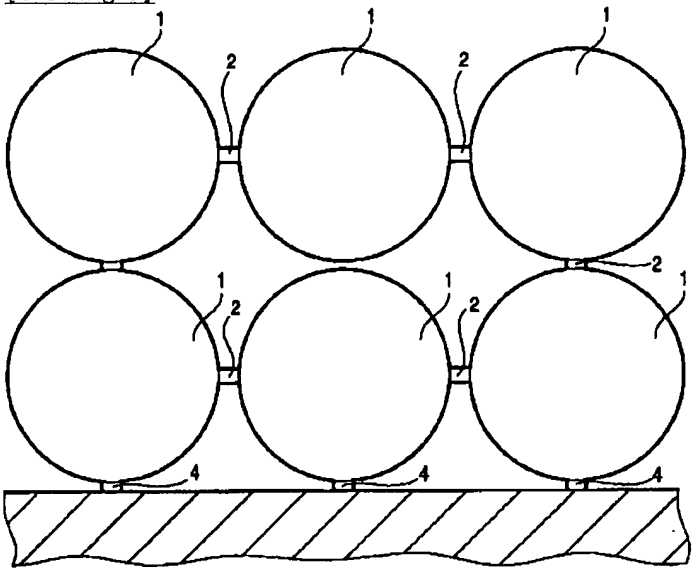
[Drawing 7]



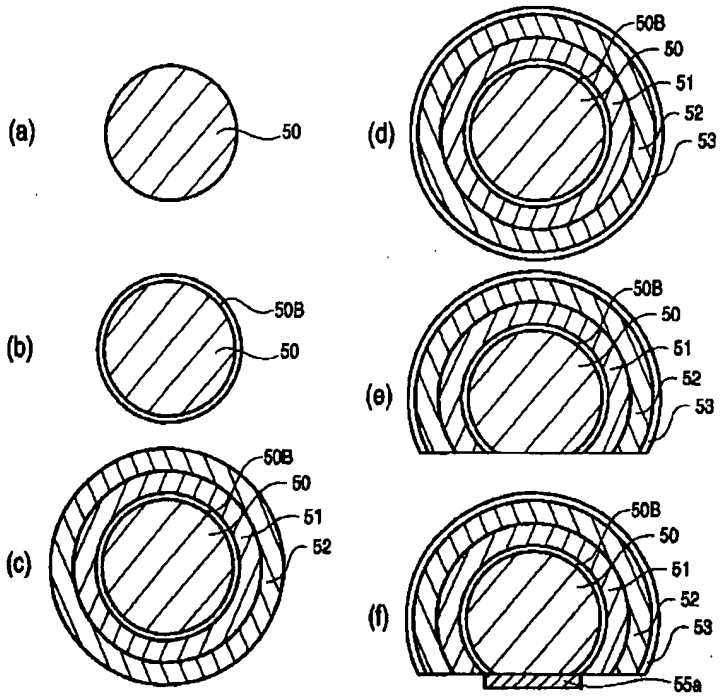
[Drawing 8]



[Drawing 9]



[Drawing 11]



[Translation done.]

WRITTEN AMENDMENT

---------- [procedure amendment]
[Filing Date] June 13, Heisei 12 (2000. 6.13)
[Procedure amendment 1]
[Document to be Amended] Description
[Item(s) to be Amended] The name of invention
[Method of Amendment] Modification
[Proposed Amendment]
[Title of the Invention] The spherical semiconductor device using the spherical semi-conductor and it containing a solar battery
[Procedure amendment 2]
[Document to be Amended] Description
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, The spherical solar-battery section formed in the predetermined field on the front face of spherical with the ground electrode which consists of transparence electric conduction film formed in the semi-conductor layer front face of said 2nd conductivity type, and the inside electrode sent for the front face while connecting with the semi-conductor layer of said 1st conductivity type,
The spherical semiconductor integrated circuit section or the logical circuit section on said front face of spherical which comes to form an inverter circuit in the field in which the solar battery is not formed is provided,
The spherical semi-conductor containing the solar battery with which a ground electrode and an inside electrode, and said spherical semiconductor integrated circuit or logical circuit of said spherical solar-battery section is characterized by interconnecting.
[Claim 2] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, The spherical solar-battery section formed in the predetermined field on the front face of spherical with the ground electrode which consists of transparence electric conduction film formed in the semi-conductor layer front face of said 2nd conductivity type, and the inside electrode sent for the front face while connecting with the semi-conductor layer of said 1st conductivity type,
The spherical semiconductor integrated circuit section and the logical circuit section on said front face of spherical which come to form an inverter circuit in the field in which the solar battery is not formed are formed,
The spherical semi-conductor containing the solar battery with which the ground electrode of said spherical solar-battery section and an inside electrode, and said spherical semiconductor integrated circuit and said logical circuit section are characterized by interconnecting.
[Claim 3] The spherical semi-conductor containing the solar battery according to claim 1 or 2 with which said spherical solar-battery section is characterized by the thing on the front face of spherical currently formed in the up semi-sphere at least.
[Claim 4] The spherical semiconductor device using the spherical semi-conductor containing the solar battery characterized by being the spherical semi-conductor with which at least one spherical semi-

conductor in two or more spherical semiconductor devices contains a solar battery according to claim 1 or 2 in the semiconductor device by which cluster connection was made through the bump in two or more spherical semi-conductors.
[Claim 5] The spherical semiconductor device using the spherical semi-conductor which contains at least the solar battery according to claim 4 characterized by arranging the spherical semi-conductor of the spherical semiconductor devices by which cluster connection was made in the semiconductor device by which cluster connection was made through the bump in two or more spherical semi-conductors with which the solar battery was formed in all on the front faces of spherical outside.
[Claim 6] Said two or more spherical semi-conductors are the spherical semiconductor devices using the spherical semi-conductor which contains the solar battery of a publication in claim 4 characterized by providing the bump who connects with a ground electrode and an inside electrode, respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carries out phase opposite, and carrying out the series connection to it through each bump, or either of 5.
[Claim 7] Said spherical substrate is a semi-conductor containing the solar battery according to claim 1 to 3 characterized by coming to form pn junction between the amorphous silicon layers of the 2nd conductivity type which consisted of a silicon ball of the 1st conductivity type, and was formed in the front face of said silicon ball.
[Claim 8] Said spherical substrate is a spherical semi-conductor containing the solar battery according to claim 1 to 3 characterized by consisting of a metal spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Claim 9] Said spherical substrate is a spherical semi-conductor containing the solar battery according to claim 1 to 3 characterized by consisting of an insulating spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Claim 10] Said 1st and 2nd silicon layers are the spherical semi-conductors containing the solar battery according to claim 8 characterized by being an amorphous silicon layer.
[Claim 11] Said spherical solar-battery section is a semi-conductor containing the solar battery according to claim 1 to 3 characterized by being the thing which comes to form pn junction between the impurity diffused layers of the 2nd conductivity type formed in the front face of the spherical silicon of the 1st conductivity type.
[Procedure amendment 3]
[Document to be Amended] Description
[Item(s) to be Amended] 0009
[Method of Amendment] Modification
[Proposed Amendment]
[0009] The spherical semi-conductor containing the 1st solar battery of this invention The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, While connecting with the ground electrode which consists of transparence electric conduction film formed in the semi-conductor layer front face of said 2nd conductivity type, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section formed in the predetermined field on the front face of spherical with the inside electrode sent for the front face, The spherical semiconductor integrated circuit section or the logical circuit section on said front face of spherical which comes to form an inverter circuit in the field in which the solar battery is not formed is provided. The ground electrode and inside electrode of said spherical solar-battery section, Said spherical semiconductor integrated circuit or logical circuit is characterized by interconnecting.
[Procedure amendment 4]
[Document to be Amended] Description
[Item(s) to be Amended] 0010
[Method of Amendment] Modification
[Proposed Amendment]
[0010] Since according to this configuration the semiconductor integrated circuit section or the logical circuit section of one spherical semi-conductor which comes to form an inverter circuit in a front face in addition to the solar-battery section is formed and the solar-battery section, the semiconductor integrated circuit section, or the logical circuit section interconnects, the small and efficient spherical semi-conductor which can supply the generated output from a solar battery to a direct semiconductor integrated circuit or a logical circuit can be obtained.

[Procedure amendment 5]
[Document to be Amended] Description
[Item(s) to be Amended] 0011
[Method of Amendment] Modification
[Proposed Amendment]
[0011] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 2nd of this invention, While connecting with the ground electrode which consists of transparence electric conduction film formed in the semi-conductor layer front face of said 2nd conductivity type, and the semi-conductor layer of said 1st conductivity type The spherical solar-battery section formed in the predetermined field on the front face of spherical with the inside electrode sent for the front face, The spherical semiconductor integrated circuit section and the logical circuit section on said front face of spherical which come to form an inverter circuit in the field in which the solar battery is not formed are formed. The ground electrode and inside electrode of said spherical solar-battery section, Said spherical semiconductor integrated circuit and said logical circuit section are characterized by interconnecting.
[Procedure amendment 6]
[Document to be Amended] Description
[Item(s) to be Amended] 0012
[Method of Amendment] Modification
[Proposed Amendment]
[0012] Since according to this configuration the semiconductor integrated circuit section and the logical circuit section of one spherical semi-conductor which come to form an inverter circuit in a front face in addition to the solar-battery section are formed, the solar-battery section, the semiconductor integrated circuit section, and the logical circuit section interconnect and the direct supply of the generated output from a solar battery can be carried out at both an inverter and a logical circuit, a smaller and efficient spherical semi-conductor can be obtained.
[Procedure amendment 7]
[Document to be Amended] Description
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]
[0013] According to the 3rd of this invention, the spherical solar-battery section is characterized by the thing on the front face of spherical currently formed in the up semi-sphere at least.
[Procedure amendment 8]
[Document to be Amended] Description
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[Proposed Amendment]
[0014] Since according to this configuration the solar battery is formed in the up semi-sphere even if there are few spherical semi-conductors, light-receiving of a solar battery becomes efficient.
[Procedure amendment 9]
[Document to be Amended] Description
[Item(s) to be Amended] 0015
[Method of Amendment] Modification
[Proposed Amendment]
[0015] According to the 4th of this invention, in the semiconductor device by which cluster connection was made through the bump in two or more spherical semi-conductors, it is characterized by being the spherical semi-conductor with which at least one spherical semi-conductor in two or more spherical semiconductor devices contains a solar battery according to claim 1 or 2.
[Procedure amendment 10]
[Document to be Amended] Description
[Item(s) to be Amended] 0016
[Method of Amendment] Modification
[Proposed Amendment]
[0016] Since each semi-conductor is spherical and light can be received although it is inferior to an outside not only with an outside spherical semi-conductor but an inside spherical semi-conductor while being able to constitute equipment in high density more, since two or more spherical semi-conductors can be constituted two-dimensional or in three dimension by making cluster connection of two or more

spherical semi-conductors through a bump according to this configuration, the generation of electrical energy by the more efficient solar battery can be performed.
[Procedure amendment 11]
[Document to be Amended] Description
[Item(s) to be Amended] 0017
[Method of Amendment] Modification
[Proposed Amendment]
[0017] According to the 5th of this invention, it is characterized by arranging the spherical semi-conductor of the spherical semiconductor device by which cluster connection was made with which the solar battery was formed in the outside at least for all on the front faces of spherical in the semiconductor device by which cluster connection was made through the bump in two or more spherical semi-conductors.
[Procedure amendment 12]
[Document to be Amended] Description
[Item(s) to be Amended] 0018
[Method of Amendment] Modification
[Proposed Amendment]
[0018] According to this configuration, when the spherical semi-conductor of the outside of two or more spherical semi-conductors by which cluster connection was made arranges the spherical semi-conductor with which the solar battery was formed in all on the front faces of spherical, the generation of electrical energy by the more efficient solar battery is attained.
[Procedure amendment 13]
[Document to be Amended] Description
[Item(s) to be Amended] 0019
[Method of Amendment] Modification
[Proposed Amendment]
[0019] According to the 6th of this invention, two or more spherical semi-conductors are characterized by providing the bump who connects with a ground electrode and an inside electrode, respectively on the front face on the same diameter on the front face of a ball passing through the level surface containing a diameter which carries out phase opposite, and carrying out the series connection to it through each bump.
[Procedure amendment 14]
[Document to be Amended] Description
[Item(s) to be Amended] 0021
[Method of Amendment] Modification
[Proposed Amendment]
[0021] According to the 7th of this invention, said spherical substrate consists of a silicon ball of the 1st conductivity type, and is characterized by coming to form pn junction between the amorphous silicon layers of the 2nd conductivity type formed in the front face of said silicon ball.
[Procedure amendment 15]
[Document to be Amended] Description
[Item(s) to be Amended] 0023
[Method of Amendment] Modification
[Proposed Amendment]
[0023] According to the 8th of this invention, it is characterized by said spherical substrate consisting of a metal spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Procedure amendment 16]
[Document to be Amended] Description
[Item(s) to be Amended] 0025
[Method of Amendment] Modification
[Proposed Amendment]
[0025] According to the 9th of this invention, it is characterized by said spherical substrate consisting of an insulating spherule, forming in said spherical body surface the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, and coming to form pn junction.
[Procedure amendment 17]
[Document to be Amended] Description

[Item(s) to be Amended] 0027
[Method of Amendment] Modification
[Proposed Amendment]
[0027] According to the 10th of this invention, it is characterized by said 1st and 2nd silicon layers being amorphous silicon layers.
[Procedure amendment 18]
[Document to be Amended] Description
[Item(s) to be Amended] 0029
[Method of Amendment] Modification
[Proposed Amendment]
[0029] According to the 11th of this invention, said spherical solar-battery section is characterized by being the thing which comes to form pn junction between the impurity diffused layers of the 2nd conductivity type formed in the front face of the spherical silicon of the 1st conductivity type.
[Procedure amendment 19]
[Document to be Amended] Description
[Item(s) to be Amended] 0080
[Method of Amendment] Modification
[Proposed Amendment]
[0080]
[Effect of the Invention] Since the solar-battery section, the inverter circuit, or the logical circuit is provided on one spherical semi-conductor front face according to this invention as explained above, it becomes possible to offer a small and efficient power unit.

[Translation done.]